PART VI

POLICY

CONSIDERATIONS

Chapter 19

LAND USE

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That urban transportation and urban land use are related is not at issue; observation and common sense confirm that they are. The debate is over the nature and extent of this relationship and how it can and should be incorporated into urban planning and development processes. Management of the transportation—land use relationship is seen as a way to solve social problems. Depending on the eye and values of the beholder, scenarios of the future of the metropolis are set forth. Claims, beliefs, and assertions form a puzzle. The puzzle is an important one, since today's actions may be costly or valuable in ensuing years, depending on what the future holds.

Alternative views of the future reflect, in part, different disciplinary perspectives and different assumptions about what is desirable and feasible in transportation and land use. For example, many transportation analysts and some urban geographers foresee an urban and metropolitan future of continuing decentralization and specialization of places, with the automobile remaining and gaining as the principal mode of travel. In this view, the social and economic forces dispersing activities and travel patterns are so great that there is no hope of redirecting them; there is little hope for increased transit ridership, much less transit-induced changes in land use. The main need for the future, in this perspective, is a cleaned-up and more energy-efficient automobile, plus investments in highways to serve dispersed patterns of development.

In contrast, transit advocates (among them a number of urban planning professionals) imagine a considerably different future: one in which substantial improvements in transit service induce major rearrangements of urban land use. Their vision is that new transit investments will create new land development patterns: residential land uses will be denser, and office and retail activity centers will evolve at interchange points on transit lines. In turn, this changed and neatly arranged pattern of land uses served by transit will decrease the consumption of fuel, farmland, and

other resources. It also will decrease travel times on foot and bicycle as well as on transit. The city will be a better place to live and more parsimonious in its use of resources. The federal Urban Mass Transportation Administration and some state and local transit agencies believe so strongly in this scenario that they promote "value capture": using the increases in land value from transit investment to help pay for the transit system.

A third vision of the future is driven by environmental and energy constraints. In this view, often held by environmentalists, air pollution and the threat of global warming, along with increasing costs of energy and concerns over the loss of farmland and other open space, of necessity will force policy changes to reduce auto use and suburban sprawl. As auto travel is restricted and as public policies are reoriented to favor compact growth, denser urban and suburban centers and subcenters will result, and transit use, cycling, and walking will increase. Cars will become cleaner and more energy efficient, though their use will be less frequent; telecommunications will serve as a substitute for an increasing number and variety of trips.

Economists often paint still another scenario. They see a mishmash of dysfunctions: subsidies, cross subsidies, ignored externalities, and inappropriate institutional arrangements and regulatory controls. Eventually, in their view, the biases, costs, and failures of the current system will lead decision makers to opt for market-oriented strategies. Congestion pricing, emissions fees, and other charges that reflect the social costs of transportation and land-use choices will be applied. Price signals then will help restructure the urban and metropolitan landscape to a more efficient one.

Many more scenarios could be created by combining land use, transportation, economic, and environmental factors in different ways; by considering different time frames; or by adding new ingredients. But our task is to enrich the reader's understanding of the possibilities, choices, and consequences, and for this we turn to history, theory, and empirical evidence for guidance.

HISTORY

Historical observation reveals strong ties between transportation and the development of cities throughout the world. Ancient religious, market, and government centers grew and extended their influence through the control of movements through mountain passes and along waterways and land routes. Early roads and ports were developed to facilitate trade, extract resources from the hinterlands, and maintain political and social control. The exchange of goods and ideas in turn fed city growth. Later, technological developments in water, rail, and road transport further aided advantaged cities to grow and prosper, while opening up new opportunities for land development as well as new ways of carrying out social and economic activities.

EARLY DAYS IN THE UNITED STATES

United States transportation and land development history initially followed the same course. Water transportation technology and water routes dominated the colonial period as well as the early days of the nation; cities grew up first on the ports and then on the rivers. Louisville, Kentucky, at the falls of the Ohio River and Cincinnati on its great north bend are examples of inland cities that drew their comparative advantages from a network of waterways. Numerous cities on the Atlantic seaboard developed at the fall line between the crystalline rock of the Piedmont and the flatter coastal plain with its water access to the Atlantic. Later, the destinies of these places waxed or waned depending on land uses in their hinterlands and their transportation connections to those hinterlands. For example, land-use and trade patterns tied to the Erie Canal helped give New York its early advantage over Boston, Baltimore, and Philadelphia.

In the eastern United States, the development of railroads tended to reinforce, in the main, the fabric of urban development and rural land uses established by waterways, although St. Louis lost its dominance to Chicago. Rail created new opportunities in some instances; Atlanta and Indianapolis owe their locational advantages mainly to rail. The settlement of the semiarid and arid West and the Pacific states was a somewhat different story; but there, too, transportation set the major patterns for urban and rural development.

Looking at the way cities were built during these periods, it is clear that transportation also gave a heavy imprint to urban form. Most cities got started during walking, wagon, and buggy days. Transportation was expensive, and the older parts of today's cities have a dense network of streets reflecting the early need for short transportation routes. Often, the old parts of cities are near waterfronts, for good access to that transportation technology was needed. It is no surprise that the streets in Manhattan providing access to the waterfront are closely spaced relative to those oriented up and down the island, because this grid accommodated the early pattern of movement.

Starting in the latter half of the nineteenth century and continuing through the first decade or so of the twentieth, horse-drawn trams, cable cars, suburban rail passenger service, and streetcars all affected the pattern of urban routes and land uses. These mass transportation modes greatly increased the amount of land within commuting distance of the urban center, and they are widely credited with supporting early suburbanization. Indeed, they were marketing tools of land developers and home builders from coast to coast.

Bicycles also affected the urban route and land-use pattern during this period. Bicycles were the first mode to make personal transportation widely available, providing low-cost mobility to men and women, youths and adults. The bicycle also quite literally paved the way for the automobile, for bicyclists were advocates of improved roads, which they soon had to share with motorcars.

The automobile era began around 1900 or a few years later. This was a time when cities were truly booming; the greatest rate of urban growth in this country occurred around the turn of the century. Immigration, industrialization, and mechanization of

farming were in full swing, and the nation was in the throes of vast social and political reorganization stimulated by these changes.

Early in the l900s several ingredients came together: numbers of automobiles attempted to operate in urban areas; the "city-beautiful" movement (which had begun several decades earlier) was at its peak; and urban-based, public-spirited, "good government" organizations were promoting new forms of governmental organization for the delivery of urban services. American cities began to engage in early forms of transportation planning and traffic engineering, intertwined with the broad goals of the city-beautiful movement. American cities' parkways and large parks stem in the main from this period: Philadelphia developed its parkway from City Hall to Fairmount Park; Chicago and Milwaukee began their lakeside parkways and parks; leaders in Pittsburgh dreamed of emulating hilly Mediterranean towns.

Professional departments of public works or city engineering were established, an outgrowth of efforts to apply scientific management principles and efficiency criteria to government. Arterial and local street hierarchies, capital improvement programs, and methods of finance including infrastructure bonds, assessment districts, and user fees were developed. Provision of good roads increasingly was seen as a government responsibility, though transit generally remained in the private sector.

Land use, in contrast, was mainly a laissez-faire matter. Some government controls did apply: subdivision requirements were established to reduce fraud and keep titles clear, and building codes were put in place to prevent fire hazards and sanitation risks. Gradually, these rules were expanded to control building height and bulk, as well as health and safety matters, and to require subdividers to make on-site dedications of streets, parks, and other sites for public uses. Yet, for the most part, developers decided how land development should proceed, and property owners determined the uses made of their buildings.

The transportation—land use relationship during this period was straightforward: transportation was put into place to serve development. Broad debates did occur about the automobiles and transit, about regional planning, and about arrangements of residential and industrial areas, but for the most part these were just debates.

The exception came over the desirability and constitutionality of zoning, an issue that reached the U.S. Supreme Court in 1926 in a case involving Euclid, a suburb of Cleveland. The court ruled in Euclid's favor, and zoning was quickly adopted in cities across the country, aided by the federal government's promulgation of a model state enabling act. But by the time that land-use control by zoning had come into its own, the Great Depression and World War II severely slowed land development, leaving the zoning instrument with little to do. Typically, existing patterns of land uses were surveyed, and zoning ordinances were adopted to protect these existing land uses from prospective nonconforming ones—not much of a challenge to development practices when so little development was taking place. Existing conflicts, on the other hand, persisted since the zoning instrument addressed existing problems only with difficulty.

THE POST-WORLD WAR II PERIOD

Post-World War II development activities reflected a mood of making up for lost time. Two decades of rapid residential suburbanization occurred; industrial, commercial, and service activities also grew and shifted spatially with the suburbs. Automobile ownership and use recovered their prewar rates of expansion. Local government mechanisms for the provision of local streets and arterials continued to function as suburban development proceeded; transportation was provided to meet emerging growth and land-use needs. Such mechanisms also functioned for the delivery of other infrastructure activities such as water supply and sewage treatment; also, the suburbs were zoned, and generally developers were required to comply with subdivision standards.

But growth and recovery were not evenly shared. In comparison to the suburbs, the inner cities did not fare well; some began to lose population relatively, and some lost absolutely. All faced problems of housing, public health, education, transportation, criminal justice, and finance. Also, pressed by modal competition and market shifts, transit systems—which had enjoyed a boom during World War II following Depression hard times—were gradually driven to the brink of bankruptcy and beyond.

During this period a powerful new element entered the transportation infrastructure: federal funding of freeways. Limited-access highways had been tested in parkways and other early designs, but planning for modern freeways began in earnest soon after World War II, particularly in the states of California and Washington and in the cities of Detroit and Chicago. Eastern states and some states in the South built early models as toll roads, and the debate at the time was not over whether to build high-performance roads, but how to finance them. The debate was resolved in favor of "user fees" (excise taxes), rather than tolls, with the federal interstate legislation and funding in 1956, and the freeway movement leaped ahead.

What was new and what was not new?

Transportation and land use for the most part continued in the framework established in earlier decades of the century: the provision of transportation continued to be steered by development goals. Streets were intimately tuned to land development. The grid of arterials was expanded as land was converted to urban uses, and as this land was developed, local streets were built. The addition of freeways changed the size and scope of transportation, but not its relationship to land use, because the freeways also were planned and built to serve the expected expansion of urban development.

What was new was heavy federal and state government involvement in urban transportation. Although just before World War II some federal aid had become available for the urban extensions of the state highway systems, both the amounts and the level of oversight were minor. The new involvement was not. The urban portions of the Interstate Highway System were eligible for federal funding on a 90% federal—10% state match. Additional federal money came with revised programs for other major and minor urban roads. Federal interest in the planning process was felt through the mandating of procedures, as well as through federal review over those proposed projects where federal money was involved.

The federal interest in urban areas was also manifest in many programs other than transportation. While there had been some Depression-era federal interest in housing, federal interest in the general well-being of urban areas expanded in postwar years. Urban renewal programs were undertaken on a massive scale. Assistance programs for housing expanded. The scope of federal involvement enlarged to cover many other programs for schools, health, welfare, sewage, water quality, air pollution, urban design, and public transport.

In the main, then, the years following World War II were ones in which historical transportation and land development relationships continued, but with an augmented cast of characters, primarily because transportation and land-use planning, financing, and other development processes had increased levels of federal involvement.

AN EMERGING DEBATE

Freeway planning procedures during this period estimated the physical expansion of the urban area and then located and sized freeways according to the travel implications of spatially extended land uses. The process was the old process: build facilities to support development. The new roads were to serve the inner cities as well as the suburbs and interregional connections so as to share the new transportation benefit widely. But in urban areas the interstate designs meant significant disruption of the urban fabric, and soon objections started to surface.

By the time that interstate building reached full swing in the 1960s, a great freeway revolt was underway. In retrospect, warning signs had been visible in urban highway controversies in the 1950s and even earlier. But the 1960s were a time of civil rights gains and mass protests; this time the freeway opponents could insist on being heard.

The revolt had a land development ingredient; it was marked by community resistance to construction through established residential neighborhoods and commercial districts. But its roots, to the extent that they can be traced, seem to go much deeper than that immediate issue. The freeway revolt seemed to stem, in part, from the belief that the continued building of freeways tilted the competitive balance against the inner city versus the suburb and was directly or indirectly responsible for a host of urban social problems. The revolt also reflected public concern about converting rural land to urban uses, about air pollution and the environment, and perhaps about the cumbersome and complex transportation planning and decision processes in which citizens had little part. On this latter point the cities won a victory of sorts early in the 1960s: a continuous transportation planning process was required of areas greater than 50,000 in population, and local officials were given the ability to veto state highway proposals by omitting them from the urban-area plans.

With the freeway revolt came the beginnings of a great national debate about urban transportation: transit versus the automobile, transportation's effects on urban form, the use of land resources by transportation, methods of finance, the incidence of cost and benefits. One thrust of the debate was that transportation must somehow be more neutral, more balanced. It was argued that automobiles and highways overly dominated urban movements, a modal balance must be restored. The need of some

for other forms of transportation became one argument for the preservation and enhancement of transit and helped bring about the passage, in 1964, of legislation providing for federal capital grants to transit systems, most of which by then were in great financial difficulties.

The balanced-transportation argument also had a land-use content. Transportation policy, according to this view, had not been neutral; it had disadvantaged locations in the central city versus locations in outlying areas. Transportation thus was blamed for the decline of the central city, and in particular central business districts, vis-à-vis other parts of the metropolitan area. Here, too, investments in center-serving transit as well as suburb-serving highways were seen as an apt prescription.

Arguments for balance and neutrality aside, the funding for highways was assured, supported by fuel and other taxes distributed by formula, while transit funds were limited and their award discretionary. Highway spending continued to far outstrip that for the transit modes even in areas where transit was heavily subscribed. Yet, despite the highway investments, capacity problems did not disappear; new roads often were congested practically from the day of opening.

The early expectations that new transit investments would stem the loss of market share to the auto also were soon disappointed. Arguments began to be heard that building more facilities and adding more equipment were not necessarily the answer to either highway or transit problems. Too much attention was being placed on fast and efficient movement, this argument went in part; other concerns, including environmental quality and neighborhood preservation, might sometimes outweigh concerns about transportation per se. Sound decision making in such instances might mean foregoing a transportation project or substantially reducing its scale or design.

Concerns about environmental impacts came to the fore in the late 1960s and early 1970s. The environmental impacts of highways received increasing attention following the passage of the National Environmental Policy Act of 1969 and the Clean Air Act of 1970. In 1972, highway legislation itself mandated greater attention to social, economic, and environmental factors. Initially, transportation agencies resisted both the time and dollar costs of environmental assessment requirements and the implication that mobility values might be traded off against other societal objectives. Highway agencies asserted that projects already far along in planning and development should be excused from the requirements; transit agencies proposed that their projects should be exempt because they surely were good for the environment. But the courts rarely found either argument persuasive, and impact studies gradually came to be accepted.

Major social and economic evaluations of both highway and rail transit programs also were undertaken during this period. Economists questioned whether motorists pay the full cost for their transportation, particularly the cost of externalities such as air pollution, noise, and accidents. Other social scientists focused on who benefited from highway and rail projects, versus the incidence of costs and other negative impacts. Studies suggested that buses could provide service as good as or better than that of rail and that carpools often were even more cost-effective. Other studies investigated the costs of sprawl and the role that infrastructure investment had played in supporting it.

The questioning of capital expenditures reflected a broader mood of the times, to emphasize better management of existing resources rather than investment in new ones. Transportation system management (TSM) was the name given to the collection of low-cost strategies for urban transportation endorsed by both federal highway and transit officials. Revamped transit operations were emphasized in place of or as a precursor to additional capital investment (operating subsidies also became available during this period). Rather than further widen streets and highways, congestion relief was to be sought through actions such as better signal timing, high-occupancy vehicle incentives, and metering of freeway ramps. The energy crises and air-pollution-control requirements of the 1970s added to the emphasis on TSM, and the same list of actions became contingency strategies in energy plans and transportation control measures in air quality efforts. Whatever the name for the measures, they also were used as arguments for not raising fuel taxes or investing in additional freeways.

Though the national attention during this period was on better management of existing investments, at the local level many communities were struggling to keep up with growth. Concerns over the effects of growth were particularly at issue where demands for public infrastructure and services were outpacing the local government's ability to deliver them and straining local government budgets even with tax increases. Some communities simply altered their subdivision requirements and zoning regulations to substantially increase lot size and restrict the number of housing units that could be developed, thereby increasing tax income relative to service requirements. Many other communities were more accommodating to development: rather than clamping down on it, they called upon developers to take increased responsibility for streets, sewers, and parks. A few jurisdictions pioneered regulations that combined capital programming and finance with the timing of development approvals, making development contingent on the availability of needed facilities and services. In some instances, developers were given the choice of waiting for the local government to provide these services (often, in accordance with a 20-year program of expenditures) or providing them themselves.

Concerns about urban sprawl, air pollution, energy profligacy, and loss of natural landscapes and farmlands sometimes brought about changes in land-use controls as well. To encourage compact development and infill and to preserve open space, annexations were restricted and urban limit lines, greenbelts, and agricultural preserves were established. Impact assessments were increasingly used as the basis for more extensive and larger, developer exactions and impact fees. In some communities, debates erupted over the effects of rapid population increases, and caps were established on the number of housing units that could be authorized annually. A few places even established overall population maxima. Growth control measures were initiated both by city and county boards and, in some areas, by citizens directly. Concerns about local finances, along with taxpayer distrust of the local government's management capabilities, fueled many of these actions.

In the 1980s the consequences of the policies of the previous decade began to be visible. The 1980 census revealed that the shift to the suburbs had not been deterred; nearly half the work trips no longer headed downtown. Transit had lost market share

in most places, despite both capital and operating subsidies. As the decade proceeded, highway congestion again became an issue, but this time the problem extended to the suburbs as well as the city. The interstate highways also were showing their age in deteriorated bridges and poor pavements, and maintenance required increasing shares of available funds.

On the land-use side, the single-family detached house remained the choice of most American households, but affordability became an issue for many. Suburban developments on the metropolitan fringe were located and designed so that an automobile was needed for most trips. Furthermore, urban residents also increased their auto ownership and use, particularly in small- and mid-size cities where transit services were marginal and nearly all developments had plentiful free parking. One result of this auto-dependent land-use pattern was that air quality standards continued to be violated in most metropolitan areas, despite cleaner cars and tough controls on industry. Also, transportation noise was a widespread problem and automobile accident levels remained high.

By the late 1980s and early 1990s, there was a general sense that a change in direction was needed, manifest in the proliferation of "Year 2000" and "Year 2020" planning efforts. The search for a new direction reflected several factors: the interstate program was due to draw to a close in 1991, a new president was coming into office, and a new Clean Air Act was under consideration. New issues, such as the possibility of global warming fed in substantial part by auto use, had been added to the agenda; several recurring ones, such as the shortage of funds for transportation, were on the list as well. New technologies, including "smart cars" and "smart highways," were being proposed for development by some, while others argued for a reemphasis on transit investment, this time with explicit land-development programs to offer support.

ROLES AND POLICY CHOICES FOR THE TWENTY-FIRST CENTURY

Role reversal perhaps best describes one thrust of the debates about transportation and land use in the 1990s. In previous decades, transportation served land development; given a condition ripe for development, transportation was one of the factors that enabled it to happen (though the way in which transportation was made available shaped the nature of developments). The availability of transportation to the interior of the United States had influenced the growth of port cities; streetcar lines, the preautomobile street grid, and the subsequent location of arterials and freeways had shaped the fine detail of urban land development. Developers converted land at the margins of the city to urban uses, and the transportation system was put in place to provide service to the new urban fringe.

As we approach the twenty-first century, the notion that transportation should serve land development is no longer accepted on its face. Diagnoses and prescriptions of what society ought to be doing vary widely, but one thing is sure: public investments

in transportation ought not to be put into place automatically in response to development desires, but should be a tool or an instrument of explicit social policy choices.

To clarify the ways in which transportation and land development entered into this role reversal, it is useful to identify some of the expectations posed for transportation policy in the 1990s. In addition to providing fast, safe, and efficient mobility and access, transportation decisions are expected to meet a number of additional objectives.

1. *Preserving and enhancing investments made previously.* Transportation facilities and services represent important public investments that should be protected. Urban places and rural land uses also represent sizable investments, and transportation should be deployed to support inner cities, help maintain the viability of medium and small urban centers, and increase agricultural productivity.
2. *Supporting new development or redevelopment.* Transportation should serve new suburban activity centers and foster the redevelopment of inner cities; it should encourage the diversification of rural economies.
3. *Protecting environmental resources that are fragile or unique or both.* Transportation should protect coastal environments and wetlands, preserve endangered species, protect wild and scenic places, and save structures with historical value.
4. *Reversing environmental harm and improving environmental quality.* Transportation should reduce air and noise pollution; it should enhance the design quality of the built environment.
5. *Minimizing the consumption of natural resources believed to be scarce.* Transportation and land-use arrangements should decrease energy consumption and save farmlands.
6. *Redistributing income.* Transportation services should be provided to the poor as a direct surrogate for the redistribution of income and also as an instrumentality that will enable them to engage more fully in economic life.
7. *Supporting participation.* Transportation services should be provided to the elderly, the disabled, and perhaps to youth as a way of facilitating their participation in social and economic activities.
8. *Assuring cost-effective investment.* Transportation investments in capital facilities and services should meet economic efficiency criteria; total benefits should exceed total costs.

The policy proposals for accomplishing these ends include some old ideas as well as some new or revamped ones. Transportation should be managed as a multimodal, coordinated system. A full range of alternatives should be considered, including demand management and low-cost operational improvements. Capital investments in transit and highways should be cost effective. The strategies developed should protect sensitive lands; air quality, energy conservation, and noise abatement should be integral to decision making. The special needs of nondrivers, disabled people, and the elderly should be given attention. Citizens, particularly specially affected interests, should have

a say in choosing the forms and amounts of transportation services they will have. Transportation should help to redress income differences, and mobility should be available to all. Prices should reflect social costs and policy intentions. Funding should be found to accomplish these objectives, but excess spending should be avoided; investments in transit and highways should be cost effective. The coordination of transportation and land use is seen as a way to accomplish much of this agenda. Into the 1970s, according to this analysis, land developers and urban planners continued to assume that transportation would be provided to serve development—but there no longer is any assurance that this will occur. In some areas, environmental constraints or other community concerns prevent road expansion. Elsewhere, the amount of development undertaken is outstripping the financial resources for transportation improvements. In still other instances the issue is a mismatch—desires for transit but densities suited only to the auto, or vice versa. Meanwhile, transportation agencies have seen the proliferation of programs each with earmarked, isolated funds, which has led to an irrational project selection process in which projects are selected to capture federal and state "match'" even if they are not necessarily the best options or the most needed investments.

The prescribed cure is for mutually consistent land development *and* transportation investment. Requirements or inducements would provide for consistency, compatibility, and concurrent delivery of transportation facilities and services along with new development. For areas already built, programs would assist redevelopment, renewal, or retrofit. Changes in transportation finance would provide flexible funding so that the best project, regardless of mode or other specifics, could be implemented. Along with mandates to assure social equity and environmental protection, development would be implemented, and desirable land use—transportation combinations would evolve.

How feasible is such a scenario? History tells us that urban land use and transportation have been closely linked, and appearances suggest that they remain so, though the relationship may not always be a smooth one. Can policy interventions of the sort discussed improve the situation? Or in observing spatial association, historical or current, might we be observing only that land use and transportation are the outcome of a common cause that could stymie the contemplated intervention? Answers to such questions call for us to consult theory and to take a more rigorous look at the empirical evidence.

THEORY AND EVIDENCE

Land-use theory is as old as economics. Land, labor, and capital are the primary inputs of production, and as observed in the early 1900s by von Thunen1 and Ricardo,2 the use of land is determined, in part, by its location. The location of transportation facilities and the technology used specify the relative location of places. Social and economic activities and their use of land are determined by relative locational advantages.

LOCATION RENT

Beginning with patterns of causality that are taken to be elementary, we can think through the nature of land use—transportation relationships. The starting concepts are old, and they are simple. The land supply is finite. Human wants are not finite, so land has value. The values of lands with similar characteristics differ depending upon locational attributes. Land in Iowa City has higher value than land on farms in the tributary area of that city because of its more strategic location; it has a higher location rent.

How are different kinds of land uses allocated and equilibrium among land uses achieved? How does land use reflect an equilibrium between the supply of what land produces and demand? Von Thunen and Dunn,3 among others, have dealt with agricultural land uses and Isard4 and Alonso5 with urban land uses. Dunn's agricultural analysis is instructive; while rural in perspective, it provides an easy route to the urban landscape. Define

$$R_{ij} = Y_c P_{cj} - Y_c T_c D_{ij} \qquad (20\text{-}1)$$

where R_{ij} = rent of a unit of land at i producing commodity c
Y_c = yield of commodity c per unit of land
P_{cj} = price per unit of commodity c at its market at j
T_c = transportation cost per unit of commodity c, per unit of distance
D_{ij} = distance to market; the distance from the production point, i, to the market at j

Now imagine a unit of farmland located at some distance D_{ij} from the market at j. The rent calculation is simple. Take the price at the market and multiply by the yield per unit of land; this yields rent per unit of land. But this gross rent must be discounted by transportation cost, which involves the amount to be transported per unit of land, Y_c the transportation cost per unit of commodity per unit of distance, *TC,* and the distance, D_{ij}. The calculation yields the net rent at place i.

Because different commodities have different yields and transportation costs, as well as different prices, individual rent gradients would intercept at the market differently and slope from the market differently. The rent-gradient explanation for rural land use is that the farmer selects the crop that returns the highest net rent, and this selection depends upon the slopes and intercepts of the functions describing rent gradients for different crops. Equilibrium of production and price is achieved through the interaction of the market price and the quality of land where a commodity is produced.

It is not hard to stretch one's imagination and bring this thinking to the urban area. In the urban area, there are many kinds of land uses, so we must think of there

being many rent gradients. Most gradients are thought to decrease outward from the center of the urban area. Downtown business activities typically pay the highest rents in order to locate centrally. Residential land uses typically pay lower rents and tend to be nearer the periphery. In Alonso's treatment of urban land uses, users of urban land have bid rent functions that they use to calculate how much they would be willing to pay to rent a piece of land in a particular location. All actors bid against each other, and an equilibrium of land use and land value is achieved.

The theory postulates a clear causality: accessibility determines the worth of land for different uses at different locations. If transportation costs are changed, the rent gradients change; since land uses and rents for land are tied each to the other by market processes, land-use potentials are changed.

Applying this theory, we would expect to find that investments that lower the cost of transportation to an employment center would simultaneously reduce the value of residential land close to the employment center and increase the value at the periphery. Reduced commuting costs (or times, since time has value) would make it possible for commuters to spend more on housing, to travel farther, or both. If, as is usually the case, out-of-pocket costs of travel are cheap relative to housing and one can buy more house per dollar farther from the center, households will have an incentive to live farther away from their workplaces. All else being equal, then, investments in transportation are likely to decrease residential density and increase the size of the urbanized area.

Business location theory follows a similar line of reasoning. While some businesses are tied to particular sites due to needs for special qualities only available there, many other businesses can choose where to locate within an urban area by considering the relative costs and benefits of doing business at a particular place. Transportation is one such cost, for businesses need access to goods and markets, and their labor costs reflect commuting costs. If transportation costs are reduced at a particular place, businesses there will be more profitable and better able to expand; other businesses also will find the location comparatively advantageous and seek to locate there. Thus, in theory, businesses will tend to congregate at points where transportation costs are low.

Population-serving businesses, which sell frequently purchased goods and services, are a special case, because their competitive edge depends in large part on their convenience to residences. If residences decentralize, these firms follow, decentralizing this portion of the work force as well. The specific location of these businesses still depends on the relative costs of transportation to alternative locations. A general reduction in shopping-trip costs would permit population-serving firms to locate farther from residences and still be convenient to customers.

Overall, theory says that transportation improvements will tend, simultaneously, to increase employment at benefited sites and to decentralize workers' housing. Conversely, worsening transportation services will favor decentralization of jobs but support higher densities of housing.

HISTORIC PATH DEPENDENCE AND OTHER FACTORS

Location-rent theory is simple; the world involves complexities. Historic path dependence is among the processes shaping urban development that are not explicitly incorporated into location-rent theory. Yet its results are visible on just about every urban landscape. Development paths got seeded; subsequent location choices depended on previous choices. Here was where the first railroad decided to put its freight terminal. Slaughter houses were located there, along with a smoky foundry. Fashionable housing developed in one part of town, blue-collar housing in another. Such locations might have resulted from accidental choice or they might have been the best transportation-location or environmental choice for the times. Whatever the reason, early location decisions have left a long-lasting imprint on urban development.

California's Silicon Valley illustrates historic path dependence at work as an attractant for modern, "footloose" industries. Early electronics research and development and production facilities located there, spinning off from research at Stanford and other nearby research universities and finding markets in defense industries already in the area. The early locators helped attract and develop the support services and labor availability that continue to attract the location of similar and related firms. In contrast, the now defunct Chicago stockyards created an environment repelling many types of businesses and setting the tone for the development of that part of the city.

Still other factors surely enter into location decisions. In the Silicon Valley example, the availability of suitable sites for development, a positive business climate, and the high-quality California living environment also helped attract high-technology industries. In many inner city areas, ethnic and racial prejudices, restrictions imposed by lenders and insurance companies, and concerns about crime and the quality of public services have restricted development and redevelopment possibilities.

Given such complexities, can theorized land use and transportation relationships be discerned in the real world? A number of studies have investigated various aspects of the interactions, particularly focusing on the effects of transportation investments on land use, location, and economic development. These studies have used a variety of methodologies, including macroeconomic investigations, econometric analyses, and input—output modeling of national and regional effects. Before—after studies of specific facilities or regions and survey-based research on residential and industrial location choices also have been used. While many of the studies suffer from limitations (correlations, difficulty in distinguishing cause and effect, failure to distinguish economic shifts within a region from investment-induced growth, and double counting of benefits), they nevertheless offer insights. Overall, these studies find that transportation availability and quality are factors in location and development, but investments will do relatively little absent other critical factors.

An extensive record of empirical evidence exists on the impact of highways on land values, land development, and the location of urban activities. The record was particularly stimulated by Section 210 of the Highway Revenue Act of 1956, which required that nonuser benefits from investment in interstate highways be investigated.6 More recent studies were reviewed by Forkenbrock and others.7 Many relationships

were claimed, but the overall conclusions remained the same: highway investments were but one factor in a larger growth and development equation.

While highway investments have surely shaped urban areas, in most cities the question now is whether transit investments will reshape development. The empirical evidence with respect to transit is not nearly so full as it is for highways, though the record is at least as long. Spengler's classic study, published in 1930, summarized a set of investigations undertaken to clarify debate in New York City with respect to transit and land values.8 Spengler undertook a section-by-section analysis of the New York transit system and developments in its environs. His conclusion was that transit was only one of a number of development forces that, if in place, would lead to development. He observed that if factors were such that a neighborhood was declining, it continued to decline regardless of transit investment; stagnant neighborhoods remained stagnant and developing areas continued to develop.

Considerable work also has been done over the years on Toronto's experience with transit and land use. Kovach,9 Libicki,10 and Heenan,11 among others, have published separate observations on the Toronto experience subsequent to 1954, when the first leg of the subway was completed. Considerable activity-center and dense residential development occurred along the first leg, which Heenan suggested was a spillover from downtown. Subsequent development impacts were much less sharp. Both Libicki and Kovach pointed out that high-density residential development was characteristic of change in Canadian cities, and they suggested that Toronto seemed to be no different from other cities on that scale.

Some work has analyzed more recent U.S. transit investments. Boyce and others,12 and Gannon and Dear13 studied the Lindenwold line rather thoroughly. That line, completed in 1968, extends from Philadelphia into Camden County, New Jersey. Boyce's analysis suggested that major changes in Camden County turned on the availability of land and zoning restrictions. Gannon and Dear judged that the Lindenwold line enhanced the attractiveness of the downtown Philadelphia area, and that several percentage points of the increase in downtown office space might be attributed to its presence; whether this was new growth or simply a shift from other areas of the region was not addressed.

A major study was mounted in the mid-1970s to judge the impacts of the San Francisco Bay Area Rapid Transit (BART) system, which had opened a few years earlier. At the time of the study, it was generally agreed that the impacts of BART on the regional growth and development pattern had been minor. Suburban fringe areas thought to be too remote before BART may have experienced accelerated housing development, and there may have been some inducement of office development in downtown San Francisco.14 BART only served a limited portion of the region, however, and even within its service area the auto remained a faster way to travel for many trips. Thus large shifts in location probably should not have been expected.

The authors have been observing continuing development changes around BART stations. The downtown San Francisco development boom, stimulated at least in part by BART, may have backfired, as in reaction to years of rapid growth, high-rise

opponents in 1988 successfully placed a cap on building size in downtown San Francisco. Increased office and housing development has taken place around the suburban stations, in several cases after protracted struggles with local residents who opposed the higher densities. At the eastern end of the line, a boom in office development occurred at the suburban Concord and Walnut Creek stations in the early 1980s. But surveys in these offices found that few of the workers actually used BART for commuting; the stations primarily serve local residents in-bound for San Francisco, Oakland, or Berkeley. Furthermore, BART has been no assurance that growth would be stimulated. Downtown Oakland, troubled by a number of urban ills, has had only moderate success in attracting new development around its stations.

Findings from studies of the Washington, D.C., Metro and several other heavy and light rail systems have been basically consistent with the findings elsewhere. Relationships between transit investment and land development are not particularly visible unless other market and political factors are supportive of such a relationship. For less capital-intensive or place-oriented transit improvements, such as bus transfer centers, the relationships are even harder to find.15

Overall, then, the empirical evidence for highways and transit lead to similar conclusions. Transportation availability and quality affect location and land use, but so do many other factors. By itself, a highway is not likely to stimulate economic development. By itself, transit is not likely to save the central city.

Difficulty in finding relationships does not prove that they are absent. Among other things, one could conjecture the following:

- Transportation impacts on land development take a long time to work themselves out. The land-development process has not been studied over a long enough period of time.
- Transportation impacts on land development were large in the 1800s and into the early 1900s because at that time the new services offered made a big difference in the quantity and quality of transportation available. Nowadays, transportation services are widely available; projects of the size and scope being implemented make only a marginal improvement. Thus small effects are to be expected unless much bigger projects are developed.
° Transit's potential for steering urban land development is substantial, but it is often very small and difficult to discern because public policies undermine its effectiveness.

Today's development debates respond in part to these conjectures: they admit that it may take a while for impacts to appear and argue that bigger projects are needed, as well as public policies supporting desired impacts. This discussion will now turn to these responses, especially the latter, which is a subject receiving considerable attention.

COORDINATED LAND USE AND TRANSPORTATION DEVELOPMENT

The earlier discussion explored the question, If transportation is changed, how will land use change? A new question is worded differently. If land-use-development controls or inducements steering land development *and* coordinated transportation development are implemented, would desirable land use—transportation combinations result?

At the scale of street blocks, stations, and individual activities such as stores and apartment buildings, the answer to this question is surely yes. Ordinary experience or a little imagination tells us that attractive and serviceable designs linking transportation and land use can be drawn and implemented. Such designs might provide for convenience-goods shopping near single-family residences; apartments within easy access to department stores and workplaces; places to meet friends or engage in recreation after work; safe bicycle routes and pedestrian ways linking housing to commercial centers and schools; attractive and convenient transit station entrances and exits; and protection from the weather while waiting for the bus or carpool. Much attention is being given to improving transportation and land-use relations at this scale of urban design, and more surely can be done.

Particular hopes are held for land-use planning coordinated in the vicinity of rail stations and major bus transfer points. In downtowns, these often take the form of transit malls lined with shops and restaurants in a festival atmosphere or station designs that incorporate offices and high-density housing. In the suburbs, lower-density but still transit-oriented housing and commercial activities are proposed for clustering in "pedestrian pocket" subdivisions in one concept.16

Better ways to coordinate the design of streets and highways with land uses also are being considered. A rethinking of the residential grid is underway in some areas, narrowed down and designed to restrain speed and through traffic but permitting efficient layouts for transit, bicycles, and pedestrians. Where traffic is to be facilitated, land uses are restricted to ones that can coexist with traffic (or better yet thrive on it), and street designs give attention to turning lanes and signal placement and timing.

Some of these new designs have been implemented by developers looking for a better, more salable product; some have come about through the efforts of city planning staffs. The transit station concepts increasingly involve joint transit agency—developer schemes for finance and development; in some proposals the partnership would extend well beyond the immediate station area.

Closely orchestrated land use and transportation relations at the project scale, or even at the scale of subdivisions and office parks, are one thing; larger-scale regional coordination of transportation and land use is something else. Might the city be improved by plans that coordinate land use and transportation development everywhere?

Such coordination is one of the objectives of new statewide planning initiatives in Florida, New Jersey, and Washington State, as well as of older state and regional efforts in Oregon, Vermont, Minneapolis-St. Paul, and Montgomery County,

Maryland. Similar approaches are being debated in California and a few other areas. Techniques for coordinating land use and transportation at the areawide level include:

° Urban limit lines and urban development reserves.
• Mandatory consistency between local land-use plans and local and regional transportation plans.
• Requirements for the provision of adequate public facilities concurrent with development.
° Minimum as well as maximum development densities and floor-area ratios to ensure adequate development for transit to work.
• Incentives and bonuses for desired land uses and for developments that provide desired transportation and land-use amenities.
• Mandatory balancing of job growth with housing development, priced and located to match the needs and incomes of the work force.

Advocates of these techniques for large-scale coordination of land use and transportation believe quality-of-life advantages would be obtained through their use. Improved positioning of work, shopping, educational, recreational, and other facilities relative to residences would reduce trip lengths and make walking and cycling feasible. Explicit planning for alternatives to the auto would create supportive environments for their operation and use. Advantages to society overall would include decreased requirements for travel, lower energy consumption, and less air pollution; urban sprawl would be reduced, sparing valued agricultural lands and other open space.

Sometimes, the concentration of intensive trip-generating land uses is advocated so that high-capacity transit can be successfully deployed; highway improvements are foregone and parking is restricted to make the auto less attractive. This is using land-use control as a means to an end valued by transit advocates. Theory says that these strategies also would tend to provide an advantage to central locations over others and perhaps raise housing prices in the most accessible locations. Advocates counter that the benefits outweigh the costs, and any equity concerns can best be addressed on their own merits.

Excepting some land developers, advocates of the contrary point of view are not well organized; they speak through their behaviors rather than verbalized arguments. Perhaps their line of argument goes this way. No land-use and transportation coordinator can know what the Jane and John Does of the city want and what they are able and willing to pay for it, so individual choices are the best coordinator of desirable development. Market wisdom is revealed by the Does' choices, and those choices are such that urban populations are shifting from places where public transportation is relatively good to places where service is not so good, as was pointed out by Fulton.17 The Does, through their actions, are voting for low densities served by autos and highways, this argument goes, and while available evidence suggests that their choices are not much constrained by transportation services, an even less constrained world surely would improve the Does' quality of life.

Arguments have counterarguments. Advocates of greater coordination of transportation and land use counter laissez-faire arguments by pointing out that the Does' choices are made from among the transportation services and land uses now available, which in turn are framed by public policy and action. They assert that if public investments in transit equaled those in highways, the Does' options, and probably their choices, would be considerably different. They argue that if the Does paid for their parking spaces and absorbed the cost of their auto emissions, noise, and other externalities, their choices surely would change, even with today's mix of services. They also make appeals to the broader public interest in resource use generally and energy and environmental issues in particular.

Accepting appeals to social goals and the point that costing might be improved, advocates of the laissez-faire approach rebut: even so, no centralized decision maker can substitute for the wisdom of the market. The Does argue that, whatever the future brings, they can decide for themselves what they want and how to spend their own money.

Each side of the argument is shaped by images held, assumptions made, and the metaphors that color and form reasoning. Images and metaphors follow from experiences and cultural norms, and views are more diverse than those we have sketched. Yet what seems absent in these considerations is a lesson from the sweep of experience: change is certain. The current debate does not respond to that point. The debate assumes that the transportation services of the future are limited to those available today; it also assumes that today's urban activities will persist in their current forms. History says that such assumptions are hardly engraved in granite.

Perhaps the debate will be reshaped as new transportation and information services and new urban activities evolve and provide new opportunities for the organization of urban life in ways consistent with social aspirations and ecological and economic realities.

SUMMARY

This chapter began by posing alternative views of the future of urban transportation and urban land development. Historical relationships between transportation and land use were noted; particular attention was given to highway and transit investments and the associated urban development since the turn of the century.

We then examined more recent societal expectations that transportation and land use should work together to manage social, economic, and environmental issues. The notion that transportation should be both modally neutral and supportive of societal goals is to some extent a contradiction. Certainly, the pursuit of any goal favors some more than it does others, no matter how carefully goals and programs are formulated. Perhaps the dispute is more about responsiveness to claims for rights and the allocation of fair shares than about specific expenditures and programs per se.

The ability of transportation to shape land use and otherwise meet societal expectations was then examined through a look at theory and empirical evidence. Theory explains transportation and land-use relationships through location rent. Empirical studies reveal that the land-development process is a highly complex one and that transportation is just one factor bearing on land development, its patterns, and its impacts.

There nevertheless remains a tendency to propose transportation and land-use "cures" in response to issues such as urban sprawl, loss of agricultural lands, or environmental quality. Yet a closer look at such issues makes it clear that transportation and land use are often not at their core. The basic matters are the ways in which individuals organize and control their activities, make claims on resources, and consume goods and services.

Social, economic, and environmental issues become matters of public debate when they are not being adequately handled. What is missing that thwarts issue resolution? Some of the missing elements may be knowledge, consensus, instruments, and articulation. The knowledge category includes sufficient understanding of relationships so that issues can be stated crisply, as well as sufficient data so that problems can be identified and evaluated. Consensus refers to public agreements on goals and the political or marketplace formats for accomplishing them—laws, regulations, and/or markets that form instruments for problem solving. Instruments include institutions and technologies. Finally, articulation refers to coordination of the various instruments necessary for successful accomplishment.

There thus is a contrast between the way transportation and land-use questions enter into public debates about issues and the political, social, and economic processes that must be handled to manage those issues. Transportation and land use are often seen as problematic and must be considered in issue resolution; yet it is on the broader processes that issue resolution must focus: Reach consensus so that . . . Change funding mechanisms in order to . . . Clarify the nature of investment choices in order to . . . Shift regulation to affect . . . Correct prices so that . . . Develop technology to . . . .

Many expect a great deal of the transportation—land development relationship; they tend to view it as the primary shaper of urban areas and as an instrument for social problem solving. The urban transportation professional should be aware that the situation is much more complex. Transportation and land use themselves are reflections of broader and deeper political, social, and economic processes, and hence the analyst should not rely on transportation and land use by themselves to resolve societal issues. The problems to be solved are complicated, and land development is not a simple function of transportation.

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EXERCISES

19-1 Economic rent measures the value of something to a production process. For example, one might analyze the output of a factory and find that a certain machine has a value in the context of annual production; that value is the machine's annual economic rent. The economic rent may or may not be closely related to the accountant's valuation of the machine, because the accountant is concerned with the discounted purchase cost of the machine, replacement cost, and similar topics. Location rent is a variety of economic rent. Location rents are created when transportation is involved in the production process. Changes in transportation costs change relative locations and how valuable locations are in production processes. To help you understand the location-rent concept, consider the journey to and from work from a residence. (a) Suppose the cost of travel from a single family residence to and from work decreases by $1.00 per round trip. This cost decrease changes the relative location of the residence. If there is one worker in the household who makes 250 round trips to work per year, what is the annual savings in transportation cost? (b) The annual transportation cost saving is not a location rent, for location rent is associated with land at a place. The residential lot occupies 10,000 square feet. What is the change in the annual location rent per square foot of land? (c) Now suppose there are two workers in the same household. What is the annual transportation cost savings from a $1.00 decrease in round trip commute cost? What happens to the annual location rent? Discuss the implications of your answer.

19-2 Complexities are introduced into location rents and urban land markets by the myriad working, residential living, and transportation processes in urban areas. (a) To begin to develop a more general picture, graph a cross section of Eq. (19-1). (Note that distance from the center is radial and therefore would produce a three-dimensional figure.) Draw the x axis (horizontal) and label it distance. Locate the y axis (vertical) at about the middle of the x axis, and label the y axis location rent. Now sketch the relationship given by the equation; that is indicate how location rent decreases with distance from the market. (b) Keeping the y axis intercept fixed, suppose transportation cost is reduced. Use a dashed line to indicate the changed rent relationship. (c) It is not sensible to

assume that the rent intercept on the *y* axis would be unchanged if transportation cost is reduced, because less expensive transportation would increase the area where the commodity may be produced. Use a dotted line to indicate the new intercept and rent lines. Note the relative changes in rents with distance from the market. (d) The sketches are for an imaginary, simplified rural situation involving the production of a commodity around a single market. While the concepts apply in urban areas, urban areas contain a great diversity of activities and reference points from which rents may be measured. The central business district is one such point; outlying employment and shopping centers are others. Central business districts have become relatively less important in cities. What does this suggest about changing location rent gradients in cities and about relative changes in transportation services?

19-3 Historic path dependence is seeded by decisions on the location of transportation facilities, as well as by many other types of decisions. Identify and describe the consequences of an early decision about the location of a transportation facility, say, a river terminal or the location of a street car line.

19-4 It was said that transportation and land-use relations can be coordinated by good designs at a fine detail scale, say, at the detail of a transit station. "Good" is in the eyes of the beholder. Critique a design, identifying what is good and what is bad and the reasons for your conclusions. It would be interesting if several students made independent critiques and compared results.

19-5 Why do you live where you do? How important were the transportation services you use to your decision about where you live? How much would transportation services have to change before you would move somewhere else? Think about services improving somewhere else enough to make another place attractive, as well as deteriorating where you are and forcing you to move.

19-6 There are ongoing debates about transportation and land use almost everywhere. Select a debate you read about in the newspapers or hear about elsewhere. Who are actors in the debate? What are the points at issue, and what arguments are put forward to support or refute the points? What information might be needed to resolve the issue, and how might such information be obtained?